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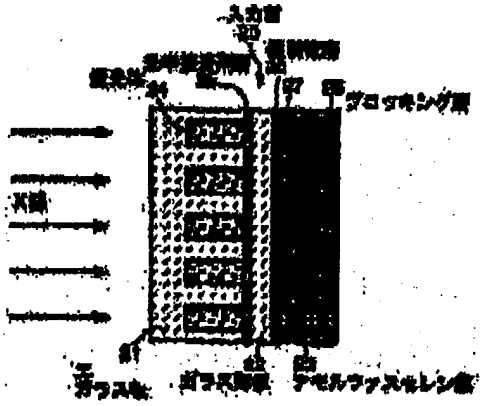
(54) X-RAY PICK-UP TUBE

(57)Abstract:
PURPOSE: To enhance the mechanical strength of an input surface without deteriorating the resolution of an image and without increasing manufacturing costs.
CONSTITUTION: A number of very fine hole parts are provided in a glass plate 21 and a fluorescent material 24 is filled up in the hole parts, and a glass thin plate 22 is bonded by an optical bonding agent layer 25. Furthermore, a transparent electrode 26 and an amorphous selenium film 23 are formed on it.



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* NOTICES *

1. This document has been translated by computer.So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] The X-ray image pick-up tube characterized by providing the following. The glass plate which has the hole of a large number distributed and arranged in the direction of a field corresponding to the pixel. The fluorescent substance with which each of this hole was filled up. The X-ray input screen constituted with the photo-electric-translation film prepared in the field of an opposite side with the X-ray incidence side of the above-mentioned glass plate. The means which reads the charge formed in the photo-electric-translation film of this X-ray input screen by the scan of an electron beam.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the X-ray image pick-up tube which is used for a medical diagnosis or non-destroying material inspection and which picturizes an X-ray image directly and acquires a picture signal.
[0002]
[Description of the Prior Art] In order to acquire the picture signal of an X-ray image conventionally, the X-ray image intensifier and the TV camera were usually combined. In an X-ray image intensifier, it has the conversion film and photoelectrical films of an X-ray-visible ray, such as CsI, an incidence X-ray is changed into a visible ray, an electron emits from a photoelectrical film according to this, and while this electron is made to carry out multiplication, the picture of the light outputs from this output fluorescent screen by carrying out image formation to an output fluorescent screen. The image pck-up side of a TV camera is made to carry out image formation of the output picture of this light through optical system. In a TV camera, the charge according to the incident light is accumulated in an image pck-up side (photo-electric-translation film), and it reads by scanning this with an electron beam, and outputs as an electric picture signal.
[0003] However, with the composition which combines such an X-ray image intensifier and a TV camera, by the time the last electric picture signal is acquired from an X-ray image, as mentioned above, like an X-ray-visible-ray-electronic-visible-ray-optical-system-visible-ray-electrical signal, it will be in the inclination for many conversion processes to be included, therefore for a conversion efficiency to get worse, and the cause and bird clapper to which the S/N ratio of the last picture is reduced will not be avoided. In order to combine an X-ray image intensifier and a TV camera with it, there are equipment's being complicated and a problem of enlarging.
[0004] Then, the X-ray image pick-up tube which picturizes an X-ray image directly and acquires a picture signal is considered. The mol farce selenium film which acquires the electrical signal amplified by the avalanche effect as the photo-electric-translation film is used for this X-ray image pick-up tube using what carried out the laminating of a fluorescent substance layer and the photo-electric-translation film as an input screen (target side). The X-ray-light is changed in a fluorescent substance layer and it is the light with a photo-electric-translation film. - The amplified electrical signal is changed.
[0005] Since the fluorescent substance layer which changes the X-ray-light usually consists of CsI and it has needle crystal structure, when a direct photo-electric-translation film is prepared in this fluorescent substance layer, the film does not become flat, but, as a result, generates partial quantity electric field within a photo-electric-translation film, and has a possibility of causing a spark etc. and destroying a pixel. Therefore, it is made to usually, form a photo-electric-translation film, after making glass sheet metal placed between fluorescent substance layers. Here, the glass plate was made thin for making it resolution not fall by diffusion of light.
[0006]
[Problem(s) to be Solved by the Invention] However, when the composition which carries out the

laminating of a fluorescent substance layer and the photo-electric-translation film through glass sheet metal like the conventional X-ray image pick-up tube was taken, glass sheet metal had the problem that it was mechanically weak and many troubles of dividing and breaking at the time of formation of a fluorescent substance layer or formation of a photo-electric-translation film occurred.

[0007] Then, using a fiber plate (FOP) instead of glass sheet metal is also considered. It can be said that this fiber plate is with there not being intensity and resolution degradation by light not diffusing even if thick, since many optical fibers are gathered, a cross section is carried out in the length direction in respect of being right-angled and it is made a tabular, and has turned to this use indeed. However, the thing of a large area of this fiber plate is very expensive, and it is difficult from the field of cost to adopt it as an actual product.

[0008] This invention aims at offering the X-ray image pick-up tube which has an input screen that intensity is high and the handling at the time of manufacture is easy, and cheap moreover in view of the above.

[0009]

[Means for Solving the Problem] In order to attain the above-mentioned purpose, the X-ray image pick-up tube by this invention The glass plate which has the hole of a large number distributed and arranged in the direction of a field corresponding to the pixel, The X-ray input screen constituted with the photo-electric-translation film with which the fluorescent substance with which each of this hole was filled up, and the X-ray incidence side of the above-mentioned glass plate were prepared in the field of an opposite side, It has been the feature to have the means which reads the charge formed in the photo-electric-translation film of this X-ray input screen by the scan of an electron beam.

[0010] The above-mentioned photo-electric-translation film can consist of amorphous selenium films which carry out avalanche multiplication.

[0011] You may make it form the hole filled up with the above-mentioned fluorescent substance with the X-ray incidence side of a glass plate, so that it may not penetrate from the field of an opposite side to the field of another side.

[0012] On the contrary, you may make it form the hole filled up with the above-mentioned fluorescent substance so that it may not penetrate to the field of another side from the field by the side of the X-ray incidence of a glass plate.

[0013] Moreover, you may make it form the hole filled up with the above-mentioned fluorescent substance so that it may penetrate to the field of another side from the field by the side of the X-ray incidence of a glass plate.

[0014] When forming the hole filled up with a fluorescent substance so that it may not penetrate from the field of an opposite side to the field of another side with the X-ray incidence side of a glass plate, you may make it prepare a reflective film in the internal surface of the hole.

[0015]

[Function] Although the light will occur if an X-ray carries out incidence to a fluorescent substance, it is made to fill up with this fluorescent substance each of the hole of a large number prepared in the glass plate. Therefore, each hole will emit light. Since it is made to distribute and arrange this hole by the direction of a field of a glass plate, each hole will call it each pixel of a picture. Since luminescence by each of this pixel is changed into a charge by the photo-electric-translation film and the two-dimensional distribution of this charge is read by the scan of an electron beam, the electric picture signal of an X-ray image is acquired. In order that distance between the fluorescent substances and photo-electric-translation films with which the hole was filled up may raise a mechanical strength since it can be made small even if it thickens a glass plate and enlarges a mechanical strength, there is no fear of the resolution of a picture being spoiled. Therefore, this photoelectric surface can be easy handling and can manufacture now an X-ray image pick-up tube easily.

[0016] By constituting from an amorphous selenium film which carries out avalanche multiplication of the photo-electric-translation film, an X-ray image pick-up tube with very high sensitivity can be obtained.

[0017] If it forms so that the hole filled up with a fluorescent substance may not be penetrated

from the field of an opposite side to the field of another side with the X-ray incidence side of a glass plate, it is possible to shorten the optical path which leads luminescence with the fluorescent substance with which the hole was filled up to a photo-electric-translation film, and resolution degradation of the picture by light diffusing in the right-angled direction for the path can be suppressed.

[0018] On the contrary, since the oak and X-ray which are formed so that the hole filled up with a fluorescent substance may not be penetrated to the field of another side from the field by the side of the X-ray incidence of a glass plate go into a direct fluorescent substance, without passing along a glass plate, they do not have attenuation of an X-ray and can raise sensitivity. Moreover, with the X-ray incidence side of a glass plate, since it can consider as a flat thing by polish etc. since it is not necessary to prepare a hole etc. in the field of an opposite side, and a direct photo-electric-translation film can be formed in the field, structure becomes easy and manufacture also becomes easy.

[0019] If it forms so that the hole filled up with a fluorescent substance may be penetrated to the field of another side from the field by the side of the X-ray incidence of a glass plate, it can also raise picture resolution by the ability leading to a photo-electric-translation film, without diffusing luminescence with a fluorescent substance while it can raise sensitivity, since an X-ray goes into a direct fluorescent substance, without passing along a glass plate.

[0020] If a reflective film is prepared in the internal surface of the hole, since it can reflect all luminescence with a fluorescent substance and a photo-electric-translation film can be made to go when forming so that the hole filled up with a fluorescent substance may not be penetrated from the field of an opposite side to the field of another side with the X-ray incidence side of a glass plate, sensitivity can be raised.

[0021]

[Example] It explains in detail, referring to a drawing about one desirable example of this invention hereafter. As shown in drawing 1 , the X-ray image pick-up tube 10 dedicates an input screen (target side) 20 and an electron gun 13 into the vacuum bulb 11 which has the X-ray entrance window 12, and is constituted. The X-ray which penetrated the photographic subject 30 carries out incidence to an input screen 20 through the X-ray entrance window 12.

[0022] An input screen 20 consists of what carried out the laminating of the micro-processing glass plate 21, glass sheet metal 22, and the amorphous selenium film 23 that functions as photo-electric-translation films. If it explains in more detail, as shown in drawing 2 , micro processing by which it sees from [of an X-ray] incidence and many holes are prepared in a rear-face side is performed to the micro-processing glass plate 21, and the hole is filled up with the fluorescent substance 24. In this case, since the fluorescent substance 24 of each hole constitutes one pixel at a time, each hole is formed in a very detailed pitch. Therefore, it is desirable to perform this micro processing with FOTORISO etching technology using photosensitive glass as a glass plate 21. That is, ultraviolet rays are irradiated, for example through the mask corresponding to the above-mentioned hole, and it **********s, using fluoric acid as an etching reagent. Since this glass plate 21 supports the whole input screen 20 mechanically, it is taken as the thickness of 1mm - about 2mm from the point of the intensity.

[0023] It is for changing an X-ray into the light, the fluorescent substance 24 with which each of this hole is filled up has X-ray absorption efficiency and high luminous efficiency, its particle size is small, and what there is moreover no deliquescence and suits the spectral sensitivity of the amorphous selenium film 23 is desirable. For example, Gd2O2 S:Tb3+, BaFCl:Eu2+, etc. can be used.

[0024] Glass sheet metal 22 has pasted the rear face of this micro-processing glass plate 21 by the optical adhesives layer 25. Furthermore on this glass sheet metal 22, the transparent electrode 26 and the amorphous selenium film 23 are formed of sputtering, the vacuum deposition method, etc., respectively. A transparent electrode 26 consists of ITO which is the alloy of an indium, tin, and oxygen. Glass sheet metal 22 is used here for making smooth the front face which forms a transparent electrode 26 and the amorphous selenium film 23. As for the thickness of this glass sheet metal 22, it is desirable to be referred to as 100 micrometers or less in order to make a resolution property good. The current blocking layers 27 and 28 for

lessening the dark current are formed in both sides of the amorphous selenium film 23.
[0025] If the X-ray which penetrated the photographic subject 30 carries out incidence to an input screen 20 through the X-ray entrance window 12, it will be absorbed by the fluorescent substance 24 and light will be emitted. The light goes into the amorphous selenium film 23 through the optical adhesives layer 25, glass sheet metal 22, and a transparent electrode 26. Since a charge (an electron and electron hole pair) occurs in it, the high voltage is impressed between the transparent electrode 26 and the electron gun 13 and field strength is 108 [V/m] grades within the amorphous selenium film 23 if light carries out incidence into the amorphous selenium film 23, an avalanche phenomenon arises and a charge increases in avalanche (avalanche). Although a strong light occurs from a fluorescent substance 24 and a lot of charges are formed in the portion in a portion with large incidence X-ray intensity for the reason, when incidence X-ray intensity is small, light also has few charges formed weakly. Therefore, the two-dimensional distribution (charge pattern) of the charge corresponding to the two-dimensional distribution (X picture) of incidence X-ray intensity will be formed in the amorphous selenium film 23.
[0026] From an electron gun 13, if the electron beam is fired towards an input screen 20 and this electron hits the amorphous selenium film 23, the current according to the charge of the portion which hit will flow between transparent electrodes 26. This current value will be taken out as voltage generated to the ends of the resistance R for example, and this voltage value will correspond to the incidence X-ray intensity in the part where the electron beam hit. Since an electron beam is made to scan an input-screen 20 top two-dimensional with the deflecting coil 14 controlled by the camera control unit 15, the picture signal (video signal of TV system) showing an X-ray picture is acquired from the camera control unit 15.
[0027] Since high electric field are applied to the amorphous selenium film 23 as mentioned above here, the front face needs to be smooth. It is because the portion which serves as high electric field locally arises, a spark etc. is caused in the portion and there is a possibility of destroying, if not smooth. Therefore, although the amorphous selenium film 23 is formed by sputtering etc. after forming glass sheet metal 22 smooth as mentioned above, since the mechanical strength of the whole input screen 20 is maintained by the micro-processing glass plate 21, it is easy to be weak [this glass sheet metal 22 very thing] in intensity, and it can make thickness thin with 100 micrometers or less as above-mentioned. Thus, since glass sheet metal 22 is thin, it decreases that the light from a fluorescent substance 24 diffuses in the direction of a field in this, and resolution does not deteriorate.
[0028] Drawing 3 - drawing 5 show the modification of an input screen 20, respectively. In drawing 3 , the hole filled up with a fluorescent substance 24 serves as a breakthrough which arrives even at the front face by the side of X-ray incidence, and an X-ray does not go into a fluorescent substance 24, after passing along a glass plate 21, it does not have attenuation of an X-ray in order to go into the direct fluorescent substance 24, without passing along a glass plate 21, and it can raise sensitivity more.
[0029] Beforehand, after forming the metal back layer 29 by making aluminum etc. adhere by the vacuum deposition etc., the fluorescent substance 24 is filled up with drawing 4 into the wall of the hole filled up with a fluorescent substance 24. Although the light generated with the fluorescent substance 24 from the difference in the refractive index of a fluorescent substance 24 and a glass plate 21 is reflected on those boundaries and it goes in the direction of the amorphous selenium film 23 even if there is no metal back layer 29 like drawing 2 Since it is not what is not necessarily reflected depending on the degree of incident angle of the light to the boundary of the fluorescent substance 24 and glass plate 21, form the metal back layer 29, make it reflect completely, all light is made to go in the direction of the amorphous selenium film 23, and it is made to raise sensitivity.
[0030] It is made to prepare the hole filled up with a fluorescent substance 24 in the field by the side of X-ray incidence in drawing 5 . In this case, like drawing 3 , an X-ray does not have attenuation of an X-ray in order to go into the direct fluorescent substance 24, without passing along a glass plate 21, and it can raise sensitivity more. With the X-ray incidence side of this glass plate 21, the field of an opposite side can raise smoothness by grinding. Then, it becomes

possible to form a transparent electrode 26 and the amorphous selenium film 23 in this field directly, as shown in drawing 5 . By taking such composition, it comes out simply [structure] and can manufacture now easily. The hole filled up with a fluorescent substance 24 is desirable, when it considers as as deep a thing as possible, that the base of the hole and the X-ray incidence side of a glass plate 21 make thickness between the fields of an opposite side as thin as possible lessens diffusion in the direction of a field of the light from a fluorescent substance 24 and resolution is raised.

[0031] in addition, this invention of many things being boiled and it being able to change in the range which does not deviate from the meaning of this invention, is natural, without being limited to an above-mentioned example and an above-mentioned modification For example, the thickness of a glass plate 21 or glass sheet metal 22, the material of a fluorescent substance 24 and a transparent electrode 26, etc. can adopt other things. Moreover, the photo-electric-translation film which carries out avalanche multiplication can also be formed with material other than an amorphous selenium.

[0032]

[Effect of the Invention] As explained above, according to the X-ray image pick-up tube of this invention, the mechanical strength of an input screen can be raised without degrading the resolution of a picture, and, moreover, a manufacturing cost is not increased.

[Translation done.]